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China's Technology Market: Linking Research to Economic Development [redacted] 25X1

An Intelligence Assessment

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An Intelligence Assessment

This paper was prepared by
Office of East Asian Analysis. Comments and queries are welcome and may be directed to the Chief, China Division, OEA,

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China's Technology Market: Linking Research to Economic Development

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Key Judgments

Information available as of 7 October 1986 was used in this report.

China, in its efforts to spur economic growth, is attempting to increase its development, distribution, and use of technology. Beijing has created, in effect, an approved market in which technologies (both hardware and processes) are treated as tradeable commodities. China claims technology transactions through this new "technology market" have improved production and increased economic productivity, although how China counts the gains is unclear. We believe that more progress in joint research and cooperation agreements between research and production enterprises will be needed before sustained economic growth through technological innovation is realized.

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Beijing is stimulating technology development and exchange activities through:

- Technology centers, fairs, and exhibits.
- Cooperative research and production contracts.
- New technology information services.
- Pilot programs to provide training and technical services to agricultural and rural industries.
- Special tax measures, loans for technology development, and venture capital funds.

Beijing views this "commercialization of technology" as key to the development and use of technology by aging industries. It expects the growing market to introduce new technology—both domestic and foreign—and facilitate its transfer to industry.

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We believe the Chinese face considerable problems in fulfilling these goals, however. They have little experience in pricing technology and must overcome ideological concerns. Some managers—who fail to see the need for new technology, or who resent the opportunities presented by the market for some individuals to earn extra income—ignore or resist the policies, and others have engaged in fraud. Beijing's efforts to control the market better by creating new oversight groups and regulations will help minimize some of these problems, but, in our judgment, Beijing will need to guard against overregulation that could stifle the innovative activity the market is designed to promote.

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The market's performance so far has been mixed. Although the market has dramatically increased the number of technology transactions, most have involved relatively low-level technology related to daily life rather than

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advanced innovations needed to promote industrial development. Moreover, most of the transactions involve small or medium-size factories rather than the larger enterprises targeted as priorities for upgrading. To remedy the situation, Beijing will select 1,000 larger enterprises to receive special benefits for technological improvements during the Seventh Five-Year Plan (1986-90), and is encouraging competitive bidding for key projects. The Chinese press claims joint research and cooperative arrangements are beginning to tackle complicated technology needs, but we remain skeptical about how widespread this is.

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On the positive side, by overcoming some of the defects of relying heavily on state administration for the management of S&T, the market, in our judgment, offers certain benefits:

- Increasing the diffusion and application of research results, particularly in rural and border areas.
- Focusing resources on developing technology needed by industry.
- Improving planning for technology development and use, at least at the national level.

The market has led to some import substitutions, with savings of foreign exchange, and Beijing expects exports of technology to result as well.

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In the long run, we believe reliance on the market poses risks for Beijing. Overemphasizing market-oriented research on consumer goods is seriously shortchanging basic research needed to support innovation in the future. The opportunity to earn extra income by engaging in market activities is also diverting some of China's most talented personnel—including students trained abroad—from teaching responsibilities, raising the possibility that China's already weak educational system will increasingly be unable to provide an adequate supply of well-trained scientists and technicians.

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For foreign firms interested in supplying technology to China, the market offers new forums for exhibiting their wares. In addition, as Chinese firms increase their familiarity with technology transferred through the market, they should be more aware of their technology needs, more realistic about the transfer process, and more knowledgeable partners in joint ventures.

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On the other hand, Chinese firms, which expect research institutes to share the risks of innovation, may exert additional pressure on potential foreign partners to bear more of the burden as well. China also intends to reduce duplication of imports by promoting awareness of technology already available within China. Moreover, China's long-term plans are to use imported technology to build indigenously the next generation of technology. These factors, in our judgment, are likely to shrink opportunities for selling some technologies, such as selected telecommunications or microcomputer production technology, to China over the long run. [redacted] 25X1

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China is counting on technology to transform its aging industries and boost production. Lu Dong, Minister of the State Economic Commission, in late 1985 told a national conference that, if the technological level of large- and medium-sized enterprises remains low, the national economy as a whole will remain low. According to Chinese press reports, he and other leaders have stated publicly that it is imperative to develop China's ability to use both indigenous and imported technology, and to speed the transfer of research results to production

To improve the contribution of science and technology to economic growth, Beijing has encouraged the commercial exchange of technology within China (see inset). According to public statements by Chinese officials, this technology market is intended to:

- Introduce new technology, materials, and products, both domestic and foreign.
- Facilitate the transfer of technology, particularly to medium- and large-scale enterprises.
- Resolve technical difficulties in production.
- Guide the absorption of technology.
- Promote the rational flow of knowledge and personnel.
- Improve the quality of Chinese products for both domestic and international consumption

The Need for a Technology Market

Chinese officials readily acknowledge that the technology market is intended to overcome obstacles that have slowed the application of S&T resources to economic development. Technology developers, for example, were isolated from end users; military research was separated from civilian research and production. Because the state assigned research priorities and provided funding, research institutes had no incentives to consider industrial needs or transfer research results to industry. Enterprises obtained technological findings free, but they were often inappropriate for the problems at hand. In addition, state production quotas and fixed prices discouraged industrial managers from exploring technological means of improving production. Beijing publicly admits that these factors and the lack of procedures for transferring technology have kept research achievements from being used effectively. Chinese officials also complain that far too many research results are never used at all

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The push for a technology market builds on a series of reforms that Beijing has been implementing over the past several years. Factory managers now have greater authority and responsibility for profits and losses; this encourages improvements in efficiency and quality of production through the use of more advanced equipment and technology.[1] Reforms of the science management structure encourage scientists and institutes to cooperate with production units by reducing the state role in funding research and by allowing both institutes and individuals to retain additional income earned from contracts with industry.

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In addition, Beijing is forcing defense industries to cooperate with civilian research and production units and to transfer military technology to civilian enterprises.[2] A series of policy and organizational changes since 1981 have led to increased coordination of military and civilian research planning and the consolidation of military and civilian research institutes and factories into specialized research and production combines. Military production of consumer goods has soared; transfer of military technology to the civil sector has increased as well, according to Chinese officials and press reports.

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China's Technology Market

What Is a Technology Market? The commercial exchange of technology. *Beijing has adopted policies that allow market forces—supply and demand—to influence technology development and sales. The goal is to use technology to spur economic growth and development*

Why Is It Needed? To channel research and technology into production. *Until recently, state authorities dictated what research was to be done and who would receive the results. Research achievements were turned over to the factory or unit for which they were intended at no cost, but generally not made available for use or sale to others. No one had responsibility for determining how useful the research had been, and, according to Chinese officials, most research was never used*

Who Is Involved? Research institutes, universities, civilian and military factories, individuals, foreign firms, industrial ministries, and state commissions. *Beijing is requiring most research institutes to become self-supporting, forcing them to look to industry for contracts. Factories are also encouraged to seek technology to improve production. Small and medium-size Chinese enterprises have been most active in technology transactions, but large factories and individuals also develop and sell technology. Most of the transactions reported in the Chinese press refer to indigenous technology, but foreign firms are also involved in the market through technology sales and participation in joint research projects. Central government organizations oversee market activity.*

How Does It Work? Trade activities vary. *Technology development and exchanges are conducted through fairs or exhibits; joint research projects involving research and production units; sales of the rights to use a technology; joint ventures for the production of a new item; contracts for technical services; technology shareholding, in which a research institute helps manage a new process in a factory in return for a share of the output value; personnel exchanges; training*

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What Kind of Technology? The simple and the sophisticated. *Technologies traded through the market range from food-processing equipment to production technology for pulp board, to microprocessor-controlled instruments.*

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Hardware and know-how. *The technology market stimulates sales of: equipment such as precision temperature gauges for the metallurgy industry, or a production line for making components for video recorders; processes, such as the use of cementing techniques to create artificial marble for the construction industry; and training or methodologies, ranging from how to conduct feasibility studies for technology projects to ways of improving quality control.* (U)

Where Are Market Activities Conducted? Throughout China. *Over 3,000 technology fairs were held in 1985 alone. Some organizations have established permanent sites for fairs or exchanges; other forums are temporary.*

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Mechanisms for Technology Diffusion and Development

The State Council paved the way for commercializing technology at least six years ago by issuing regulations to make technology a tradeable commodity. Public statements by Chinese officials and numerous articles in the Chinese and foreign press over the last two years document Beijing's attempts to make the commercialization of technology a reality.

Creating Links to Users

Centers, Fairs, Exhibits. At Beijing's urging, ministries, provinces, and local agencies are establishing forums [3] such as technology development and service

[3] Beijing uses the term "technology market" to refer both to the general concept of a commercial exchange of technology and to actual places where such trading occurs. For simplicity, this paper uses "technology market" only for the general concept; more specific terms are used to indicate public forums where buyers and sellers of technology gather

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The Beijing Technology Center

Established in late 1984 by the Beijing Municipal Commission for Science and Technology as one of the first permanent technology centers, the Beijing Center for the Development and Exchange of S&T offers scientists, research institutes, and production facilities the following services:

- *A forum for displaying technology and research results. Types of technology displayed range from printing processes to machinery for food preparation. US Embassy officials in 1984 reported they were denied entrance to the showplace, apparently because military technology was also displayed.*
- *Technical consulting. Facilitates technical consultations, scientific discussions, research coordination, and cooperation in the use of large precision instruments and other sophisticated items.*
- *Pricing and financial services. Provides guidelines for pricing technologies; collects a sales commission of up to 10 percent of the price. May assist in arranging financing through local banks.*
- *Job placement. Attempts to match S&T personnel seeking to relocate with available jobs; negotiates with prospective employers and receives commission if the applicant is hired; notifies original work unit. Also assists in tasks such as managing employee health and welfare funds, and arranging schooling for children of scientists.*

centers, fairs, and exhibits for the development and transfer of technology. They bring together scientific institutes, universities, factories, and individuals to discuss engineering problems, exchange research and results, and buy or sell technology. Some help negotiate contracts, assist prospective buyers in finding funds, and serve as brokers for the placement of S&T personnel (see inset)

The number of these forums has exploded in the last several years. According to Chinese statistics, over 1,400 science exchange centers and 3,000 technical service and consulting organizations existed by the end of 1985; 3,000 trade fairs were held last year alone

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Cooperative Links. Cooperative research and production agreements—nearly 10,000 have been signed since 1980—are bringing together those who have or can develop technology and those who need it. Chinese journal articles and press accounts report that cooperation takes a variety of forms: contracts, consultancies, joint investment in research, mutual transfer of research results, exchanges of technical personnel, training, and cooperation in the production of important technical equipment. A coal mine, two research institutes, and a factory, for example, pooled their resources to use the mine's coke-oven gas and local pottery clay to produce brick and ceramic products; the contract for cooperation covered feasibility studies, ceramic techniques, engineering design, equipment manufacture and installation, and personnel. Unlike some past administrative reorganizations, these are voluntary associations based on economic needs.

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These arrangements are breaking bureaucratic and geographic barriers by linking units from differing institutional structures and diverse locations. Research units—military and civilian; national, provincial, and local; universities and industry—are joining with production enterprises to work out ways in which technology can improve industrial processes and products. Production units with complementary interests and expertise are also joining together. Ten microwave equipment facilities, for example, have formed a cooperative group to improve their technological and manufacturing capabilities. In addition, S&T activities as part of Beijing's program of economic cooperation between interior and coastal areas—such as the exchange of technology for the metallurgy, color television, building materials, pharmacology, and other industries—are increasing. State-owned industrial enterprises in Shanghai, for instance, have exported technology to interior provinces in return for raw materials such as coal and pig iron. A Chinese newspaper article reported that technical projects

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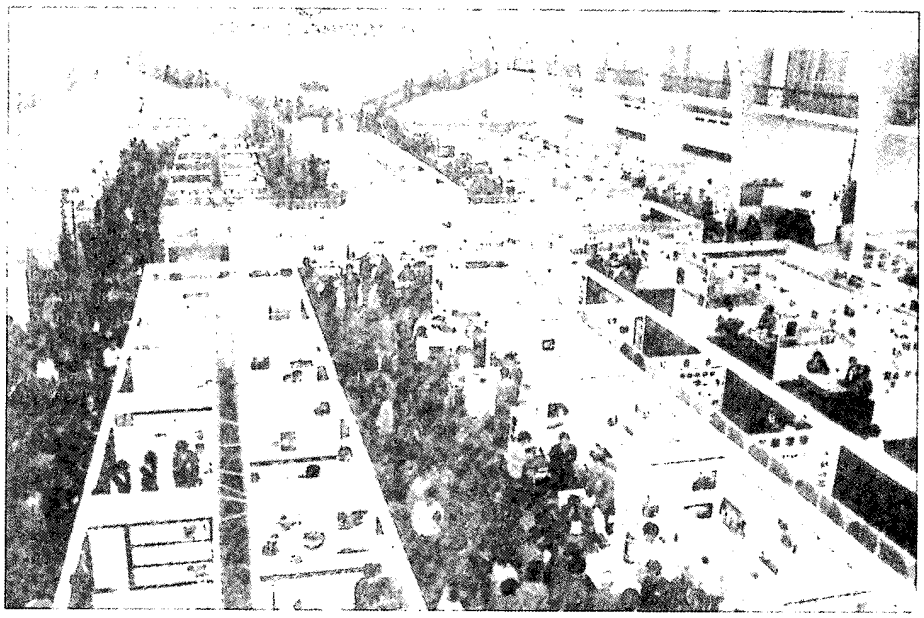
Booths at the First National Fair of Technical Achievements



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Premier Zhao Ziyang at China's first scientific and technological achievements trade fair

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accounted for 60 percent of the economic cooperation projects in 1985, compared with 40 percent the previous year.

Several S&T-related groups have set up separate technology outreach programs to work directly with potential users. According to the Chinese press, the Chinese Academy of Sciences (CAS) has founded more than 100 technology development corporations to act as a bridge between CAS research institutes and Chinese enterprises by providing, on a contract basis, CAS-developed technology to upgrade production. The Chinese Association for Science and Technology, a party organization of scientific societies, has established a new Technology Development Center to coordinate technology transfers and development activities. These organizations also will seek foreign technology needed by Chinese factories.

Supporting the Transfer Process

Information Services. China is spreading word of available technology through new information services. The State Science and Technology Commission (SSTC) is developing an S&T information network although telecommunications problems have delayed its implementation, The China Technology Market Development Center (formed in 1985) plans information banks to publicize Chinese technologies both within China and abroad, according to the Chinese press. Other creative mechanisms for spreading awareness of technologies are springing up; the Shanghai bureau of the Chinese Patent Agency, for example, displays inventions in a technology shop. Newsletters dedicated solely to promoting the technology market have also appeared.

Pilot Programs in Rural Areas. Beijing also is taking steps to see that technology is used, particularly in rural areas, by providing training and technical services to improve agriculture and develop rural industry. According to press reports, Beijing intends to establish research-diffusion-training centers in every county in China by 1990; 400 centers are already operating. As part of its "sparking plan" for applying technology to rural needs, Beijing plans to use technology to upgrade agricultural production, animal husbandry, and rural industries in such sectors as construction materials and food processing. According to press reports, Beijing intends to transform technology development projects (in 24 unspecified technology areas) into commodities for both the domestic and international markets, with each project leading to the development of new enterprises STAT STAT

Financial Support. The People's Bank of China and the S&T Leading Group [4] in late 1985 issued a joint circular calling for banks to finance technology transfers through loans. The State Economic Commission is counting on banks to provide most if not all of more than 140 billion yuan ($44 billion) to be spent on technological transformation during the Seventh Five-Year Plan, according to US Embassy officials. Possibly in response to such appeals, a bank in Xian and 10 production enterprises recently combined their assets and formed a financial group—reportedly the first of its kind in China—to provide funding for upgrading production technology. 25X1 25X1

China also is experimenting with venture capital to further encourage investment in high-risk, advanced-technology projects. The State Council in January 1986 authorized a new corporation, China Venturetech Investment Corporation, to "obtain economic results by using venture investment to accelerate and complete the commercialization process for new technologies," according to US Embassy reporting. The Embassy also reported that Venturetech was proposed by a Chinese official who was impressed with the venture capital firms he observed while studying in the United States. The State Council and the SSTC provided startup capital, and Venturetech expects to raise additional funds (including foreign exchange) from potential investors such as banks and ministries; its projected annual budget is $14 million. The company will accept proposals for funding projects in such areas as information technology, biotechnology, and new materials. 25X1 25X1 25X1

[4] Beijing has organized a number of supraministerial "leading groups"—composed of high-ranking officials from economic, education, research, and defense sectors—to cut through the inertia and bureaucratic resistance which traditionally slow policy implementation. The S&T Leading Group, established in 1983, is charged with overseeing national technology research and development plans STAT

Furthermore, provisional regulations announced by the Ministry of Finance in May 1986 provide tax breaks for experimentation with industrial innovation. According to Chinese press releases, scientific research units are temporarily exempt from business and income taxes on income from technology advising, consulting, or transfer activities and may receive tax exemptions or reductions on products resulting from their research. Taxes on incomes from investment in energy and transport facilities, or in remote areas, will also be reduced

Problems in Managing the Market

According to Chinese press reporting, implementation of these measures to spur technology trade has encountered several problems.

Establishing Prices

Continuing ideological concerns and lack of familiarity with pricing technology have complicated technology transactions, according to the Chinese press. Resolving the issue of how to place a value on technology in a manner that satisfies conservatives resistant to reform and, at the same time, provides incentives for technology development is difficult. On the one hand, a leading member of the SSTC suggested that rates for technology transfer should depend on the economic results created after applying the technology to production. An article in *Hongqi,* the party's theoretical journal, on the other hand, called for laws that prevent the appearance of "technology blockades, technology monopolies, waiting for a good price to sell, and other indecent tendencies."

Resistance

Some of Beijing's policies are being resisted or ignored. Some research institutes, for example, resist the directive that personnel be permitted to earn additional income through work on outside projects in their spare time by refusing to let them keep the money. Some universities have let workers engage in outside activities only if the university receives a significant share of the earnings. Also, managers whose products already are in great demand see no need to explore technological options for improving either their product or production processes.

Fraudulent Practices

Practices such as sales of unreliable technologies, buying and selling technologies for excessive profit, plagiarizing technologies, deception and fraud, and breaking of contracts have alarmed Beijing and discouraged potential technology buyers. Chinese officials reported that, despite the proliferation of market forums, the number of technology transactions fell sharply during the early months of 1986 as a result of such problems. In late 1985, the SSTC issued a statement ordering use of and adherence to contracts, and restricting the transfer of technology before it has been tested. A vice minister of the State Economic Commission has said publicly that those who employ trickery or make unrealistic claims should be regarded as economic criminals and should be punished accordingly. He also recommended that the seller of a technology that proves useless should compensate the buyer, and that party members involved in such cases should be expelled from the party.

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A Call for More Control

Beijing sees more and improved management of technology markets—through legislation and oversight groups—as the solution to such problems. The State Council issued provisional regulations on technology transfer in early 1985, restating the principle that any unit or individual in China is free to sell technology. To flesh out a legal framework for the emerging market, Beijing is drafting legislation on the establishment and management of technology markets, technical contracts law, and collection of market statistics. In addition, the State Council established a leading group representing many organizations to provide guidance for the development of the market (see inset). A separate Job Titles Leading Group is examining issues related to the treatment and use of S&T personnel. In October 1986, the SSTC announced the formation of a new China Technology Market Development Group, with representatives from 48 companies, research organizations, and ministries, to improve technology development and transfer activities. Establishment of another national-level permanent advisory center (with subgroups in all relevant government departments) is planned by the State Economic Commission (SEC) to strengthen control over technology transfer centers

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While additional guidance is needed, Beijing may have difficulty balancing the need to curb market abuses with the need to provide adequate incentives for technology transfer. The proliferation of groups involved in market management also raises the potential for greater managerial confusion. Nonetheless, we believe that many of the initial problems will lessen as institutes and enterprises gain experience in the market. Because Beijing's economic reforms provide additional incentives for technology innovation, enterprises should be eager to apply technology to industrial problems. The Chinese recognize that it will take time to develop the market; one SSTC official said the Technology Market Leading Group intends to put the market on the right track in a "few years' time."

Market Performance So Far: The Disappointments . . .

Low-Level Technologies

Initial market activities suggest mixed results—the market is not meeting some of Beijing's major goals, although some benefits are occurring. Much of the activity so far, for example, involves low-level technology purchased by small enterprises, such as processing techniques for foodstuffs, textiles, and the light chemical and building materials industries. Chinese journals suggest that both buyer and seller often look for a technology that can be applied quickly and with little effort, and tend to avoid advanced equipment and processes that require more effort to integrate into an existing facility. Some of the items displayed at technology fairs might not even qualify as technological achievements outside China. One S&T fair, for example, included new varieties of herbal and low-tar cigarettes.

Some of the technology transferred from military to civilian enterprises apparently is more advanced, but information on these ties is limited. The Chinese frequently cite as an example the application of temperature-control technology developed by the Ministry of Astronautics to metallurgical and textile industries. Lack of experience on the part of both military and civil enterprises with transferring traditionally sensitive and restricted military technology has slowed such transfers. 25X1

some defense facilities also have little idea of what might be useful to civilian enterprises. 25X1

Leading Group for Managing the Technology Market

The State Council established the leading group to provide national coordination and guidance for the technology market. The group consists of personnel from the SSTC, the State Economic Commission, the National Defense Science, Technology, and Industry Commission, the State Planning Commission, the Chinese Academy of Sciences, the Patent Bureau of China, the Ministry of Finance, the Industrial and Commercial Bank of China, and others STAT

Chinese articles discussing the leading group reveal that its main tasks are to: 25X1

- *Formulate strong supporting policies and measures regarding pricing, taxes, credit, and resource allocations.*
- *Promote the use of market analysis, develop a market information network to gather statistics, and carry out forecasting.*
- *Sponsor theoretical study of the technology market, including questions of value and pricing of technical commodities, and policies for distributing income from transferring the rights to technology.*
- *Establish a comprehensive trading system with a cadre of qualified people who know technology and technical operations, including the advertisement of new products and processes* STAT 25X1

Few Large Enterprises

Chinese leaders have publicly stated their dissatisfaction that larger enterprises in key sectors have not been active in the technology market. Most contracts for research have come from small and medium enterprises, which have limited resources to pay for outside research; the large enterprises Beijing sees as priorities for technological transformation tend to rely on traditional ways of doing business rather than 25X1

Technology Transactions: What's in a Number?

The Chinese press is full of glowing reports about increased trade in technology, but the numbers are contradictory and misleading. Reliable totals for the value and volume of transactions through all of China's technology trade forums are unavailable; estimates vary widely. SSTC Chairman Song Jian, for example, said the value of technology transfers in 1985 exceeded 2.3 billion yuan (US $720 million), a threefold increase over 1984. For one national technology trade fair in 1985, however, the Chinese press reported transactions totaling 8 billion yuan (US $2.5 billion). These numbers are inflated, moreover, by including tentative arrangements such as letters of intent and agreements in principle.

The numbers also do not indicate the types of different technologies involved: at one fair, the same maize- and potato-processing technology was purchased by 110 different units. Much of the activity that swells national totals occurs in China's hinterland, but provincial reporting often overstates the case. One article, for example, revealed that the local so-called technology fair occurred during the traditional mule and horse fair; sales figures from that fair appear to include purchases of wheat, sugar, and logs. The report of another fair included in its results the total sales of a new type of pulpboard, rather than sales of the technology for producing the board.

In addition, most of the transactions occurring through technology centers and fairs are relatively small. At one fair, enterprises concluded 134 contracts worth 1 million yuan each (US $310,000) and only 22 contracts worth more than 10 million yuan (US $3.1 million); 95 percent of the contracts accounted for only 5 percent of the total value of all transactions

We believe, nonetheless, that Chinese statistics—when interpreted with some caution—provide a generally accurate picture of trends in the technology market.

establishing the cooperative links to allow the introduction of advanced technology from new sources. A Chinese Academy of Sciences official told US Embassy officers that one reason some larger enterprises have not contracted for outside research is that they have their own research institutes. 25X1

another reason is that 25X1
managers are concerned that implementing a new technology would adversely affect production and reduce profits. Managers are judged on short-term output and profits, while improvements on the basis of technological innovation may only be demonstrated over the long term. Some managers are also concerned that by spreading information about a technological achievement they will lose the competitive advantage it offers them. To stimulate the involvement of larger enterprises in technology trade, during the Seventh Five-Year Plan the SEC and other agencies intend to select 1,000 large and medium-size enterprises to receive special benefits for technological transformation, including additional tax deductions, depreciation allowances, and special loans. Attitudinal barriers may be more difficult to overcome, and may depend on China's progress in implementing economic reforms that shift the responsibility for enterprise profitability to managers. 25X1

Beijing also expected the market to promote the use of competitive bidding for key projects, stimulating competition, and reducing waste. But Chinese newspapers have reported only a few examples of contracts for key projects signed at technology fairs, and it is more likely a coincidence that the long process of considering suppliers reached closure while a fair or exhibit was taking place. 25X1

Mechanisms such as fairs and exhibits, moreover, have limited use in complex specialized technology areas, in our view. Enterprises with specialized requirements or sophisticated problems need direct, extensive contact with suppliers. In addition, the more complex approval process for larger projects makes fairs and exhibits less appropriate for purchasing advanced equipment and know-how. Joint research STAT 25X1

Robotic arms from Dalian Machinery Plant: units once serving the defense sector are now making products to support China's civil-economic development. STAT

and cooperative programs have the potential to meet China's more complex technological needs. Chinese press reports indicate some of these cooperative arrangements are moving from spontaneous and small-scale pooling of resources for the development of a single item, to well-organized, well-planned efforts tackling projects for an entire industry or region. Although few specific examples are available, one that is frequently cited is the effort of four provinces and one municipality to clean up a lake so the water may be used for industrial purposes.

Limited Personnel Transfers

Another area of disappointing results is the lack of mobility of S&T workers in response to market forces. Beijing had hoped that the market, by bringing job seekers in contact with potential employers, would promote more efficient use of China's limited S&T personnel. In addition, stimulating the movement of skilled workers can be an important mechanism for transferring S&T expertise to new areas. Although Chinese surveys report that as many as 20,000 staff members from research institutes at or above the prefectural level changed assignments during 1985, many obstacles limit job shifts. At a five-day job fair in Guangzhou, for example, more than 8,700 people requested new jobs, and 3,100 were selected, but only 200 actually arranged for transfers in the days following the fair. Home units frequently are reluctant to let skilled workers go, even if their talents are not being used. 25X1

mobility of S&T personnel remains a sensitive issue, despite public endorsement by high-ranking officials. 25X1 host institutes demand "hostage fees" before agreeing to release personnel. S&T officials have told US Embassy officials that even a high-ranking organization such as the SSTC's National Research Center for Science and Technology for Development has had trouble prying people loose from their home units. Similarly, foreign joint ventures have advertised for the workers they needed, but, despite large number of applicants, have been able to hire only a few technicians. Job centers and exchanges are able to match talented people with prospective employers, but additional direction from Beijing apparently is necessary to complete the deal. 25X1

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. . . And the Benefits

Increased Diffusion, Application of Research Results

The technology market has opened up new and much-needed channels of communication about technology needs and availability, particularly for remote areas. Lack of market information had been a particular problem for rural areas which desperately need technology, according to various Chinese articles. Technology is now available to a much wider range of organizations than was possible before these mechanisms were developed.

Furthermore, the market is fostering needed links between research and production enterprises and focusing attention on technology for economic growth. Through contracts and cooperative agreements, S&T resources are being devoted to developing technology needed by factories.

cooperation between institutes is helping to eliminate the duplication of research, which has wasted resources in the past, as well as allowing institutes to learn from one another's achievements.

China's technology market also has been successful in getting more technology applied to production, and applied more quickly. One municipality, for instance, reported that between 1979 and 1985 it tripled the number of research results used in production, according to Chinese publications.

a provincial electronics institute in the past took an average of 18 years to complete a technology development project, but through contracts with industry reduced the completion time to less than two years. Hunan Province claims to have adopted 3,000 items of new technology since instituting a technology market several years ago, and says the average time needed to apply a technology to production has been shortened by one year. Some of these reports, however, with glowing accounts of dramatic increases within a short time, reinforce our belief that such transactions often involve low-level technology.

Stimulating Technology Development and Use

Research units and individuals have established links to industry, and new, private research organizations are also working on technology needed for production. A private research firm in Gansu Province, for example, developed an engineering management system for an auto parts factory that the Chinese press claims increased output value and profits 10 and 19 times, respectively. According to an article in *Tianjin's Technology Market* newsletter, such research organizations are characterized by voluntary associations, financial independence, self-management, operational autonomy, and responsibility for profits and losses. Although some of the uncertainties of such operations—tax treatment, authority for external exchanges—may need legal clarification, such firms can help bridge the gap between research and applications. Beijing hopes the market will go beyond promoting research-industry links to stimulating competition among such groups—a key factor driving technological innovation in the West—but, to date, the traditional Chinese tendency to rely on personal relations appears to be more important than economic considerations in choosing partners for cooperation.

The market also encourages individual entrepreneurs by offering opportunities to earn additional income. The first private technology achievements fair, held in May 1986, featured more than 3,500 items in mechanical engineering, electronics, light industry, chemicals, and food. According to Chinese reports, about a third of the inventors—retired technicians, university students, workers, and peasants—have taken out patents for their innovations

Improved Planning

Greater knowledge about the range of technology available is increasing awareness of the need to choose technology carefully, at least at the national level. Official statements remind enterprises that technology transfer must go hand in hand with feasibility analysis, technical planning, and demonstrations. At the same time, decisionmakers seem more conscious that the goal is not technology for technology's sake, but technology for economic development. The National Research Center for Science and Technology for Development, an SSTC organization specifically tasked with integrating scientific research with economic development, is publishing a series of technology policy papers to guide development, imports,

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and application in priority areas. The China International Engineering Consulting Corporation, on behalf of the State Economic and State Planning Commissions, screens proposals and evaluates feasibility studies for large and medium-size construction and technological transformation projects initiated under the Seventh Five-Year Plan. Chinese press reports suggest that conferences on experiences with technical transformation, consultancies, and other elements of the technology market may also be improving planning at the local level.

The greater emphasis on planning should lead to increased awareness that technology is only one input into the production process. Improved planning has also raised awareness of the need to consider the potential results of innovations. China still runs the risk of having raised unreasonable expectations, however; numerous newspaper articles recount phenomenal, often exaggerated success stories, and urge reaping the benefits of technology quickly.

China has studied US and Japanese methods for conducting technology assessments, and Chinese officials have publicly expressed their interest in assessing the effects of technology on the economic, political, and social order. Although the cost and time involved may discourage China from formally undertaking this type of study, the concept of evaluating potential impacts—and, theoretically, planning to avoid undesirable ones—clearly has considerable appeal for a leadership somewhat nervous about the Western influences that often accompany foreign technology transfer.

Production Gains

Beijing publishes glowing reports on the effect of commercial transfers of technology on production. Some gains undoubtedly have occurred, although we do not know how China counts technology items, determines a causal link between a technology and an increase in output, or measures the economic impact. According to a Chinese journal, for instance, a pharmaceutical plant moved from losses to yearly profits in excess of 2 million yuan (US$625,000) after an association with a research institute gave it access to new products; research and living conditions within the institute also improved. Similarly, Hunan Province reports a 25-percent increase in output value in the past three years as a result of new technology. Of 10,000 major research findings that won official approval or awards in 1985, 185 were reported to have produced economic returns of 4.4 billion yuan. 25X1

Many of the reported successes may refer to "technological fixes" that produce quick results because of the poor technology base in many Chinese factories, but transfers of the low-level, often inefficient, older technologies involved in most market transactions probably contribute only very modest economic gains. Raising the technological level of important Chinese facilities and industries probably will require more effort. Progress in joint research and cooperative agreements between Chinese organizations, and implementation of the many technology transfer agreements signed with foreign firms in recent years, will be needed before sustained economic growth through technological innovation is realized, in our view. 25X1 25X1

Import Substitution and Export Growth

The technology marketplace has reduced foreign exchange expenditures in some cases. Chinese officials are more aware of what other units have already imported and are therefore not importing duplicates, according to Chinese press reports. The Ministry of Machine Building, for example, canceled 88 import projects in 1986, in part because similiar technology was available in China. One factory planned to import a Japanese production line for $1.9 million, but through a technology market, according to press reports, discovered technology was available from a local university for only 380,000 yuan (US$120,000) and purchased it instead; moreover, the domestically manufactured production line was in operation one year sooner than if the technology had been imported. Chinese press accounts of the first national technology fair proudly claimed that, of 130 problems China had intended to solve with foreign technology, 59 were solved by domestic technology at the fair 25X1

In addition, China wants to expand exports to fuel economic development, and considers increased exports of its technology as the final stage in developing STAT

the technology market, according to officials. Beijing moved in that direction by holding its first trade fair for technology exports in April 1985. Press reports claim 60 foreign firms signed contracts worth 20 million yuan (US$6.2 million). Over 400 production and research units displayed 1,700 items; the star attraction was the Ministry of Astronautics offering of satellite launching technology. many of the exhibits—which included herbal medicines and garments—to be far from advanced.

Forecast for China's Technology Market

For the technology market to develop into an important tool for stimulating significant technology development, transfers, and use, more encouragement and guidance from Beijing are needed. Additional measures, such as the establishment of pilot facilities to test technologies and tax reductions for technological transformation, probably will be needed to stimulate projects involving the more advanced technology needed to boost industrial development.

In addition, the market is only one step in increasing the contribution of technology to the economy. Use of technology to improve production and output is slowed by barriers such as the shortage of midlevel technicians and engineering specialists, poor management, and an inadequate infrastructure. Beijing has begun to address these systemic problems through economic and educational reforms, but much remains to be done to improve China's absorption of technology.

Furthermore, China's technology market, like markets in Western economies, may cause diseconomies or exact social costs—such as failure to produce a socially necessary but less profitable good, or disparities in income distribution—that Beijing is unwilling to accept. If a large number of firms were unable to compete with other, more technologically advanced firms and thus forced into bankruptcy, for example, Beijing's reaction would largely be influenced by economic and political factors; in any event, Beijing is likely to play an important role in the market to deal with such externalities.

Mortgaging the Future?

Beijing's new technology market involves risks, moreover. Overreliance on market mechanisms, by reinforcing short-term thinking, can lead to an overemphasis on research related to consumer products rather than investment in complex technological development projects and basic research. Preliminary reports from Chinese press suggest this may already be occurring, with potential negative effects on China's technological capabilities in the future. Beijing in recent statements has emphasized its continuing support of basic research for long-term technological innovation. These statements are not convincing, in our view; they frequently refer to basic research that can be applied quickly to economic needs. even those state funds earmarked for basic research are instead supporting applied research, and that students overseas are encouraged to switch from theoretical to applied studies.

People's Daily has advocated use of mechanisms such as technology shareholding—in which the research institute sends personnel to the production unit to assume responsibility for use of the technology on a long-term basis in return for a share of the profits—that exact a high opportunity cost in terms of research foregone by the institute while overseeing production. Similarly, technicians—in short supply in China—often neglect their research duties to pursue more lucrative technology sales activities, according to Chinese articles.

These practices pose a particular threat to Chinese S&T education. University personnel have been expanding their involvement in applied research through contracts with industry, often at the expense of their teaching responsibilities. Students, rather than working on advanced research topics, are involved in production tasks. Western-trained personnel are drafted to oversee equipment installation and applications instead of using their newly acquired skills to further China's indigenous research capabilities or to train other students. These

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practices could seriously weaken S&T education in China and may lead to continued shortages of skilled scientists and engineers.

Outlook for Traveling Salesmen: What US and Western Suppliers Can Expect

China's programs to commercialize and popularize technology, such as technology centers and exhibits, provide new forums for Western firms, especially smaller ones, to publicize their wares to potential Chinese customers. As Chinese enterprises gain more experience with technology as a commodity, we expect them to become more informed buyers—more aware of their needs for imported technology, more familiar with the process of buying technology, and perhaps more realistic about the technology transfer process. China's ability to use imported technology should improve as well, as enterprises become familiar with more sophisticated production processes through the application of indigenous technology.

On the other hand, as Chinese factories gain experience with problems involved in technology transfer—including large initial capital outlays or temporarily disrupted production—Chinese negotiators probably will press harder for potential foreign suppliers to share or shoulder entirely the burden of adopting a technology. The technology market also raises the possibility of unauthorized diffusion of technology. Fraudulent practices—including copying of technology without compensating the owner—have been reported in the Chinese press; some Chinese journals even appear to advocate this. State Council guidance and legislation, including China's patent law, prohibit such practices, but implementation, detection, and enforcement will bear watching.

China's intention to use the technology market to reduce duplication of imports will also crimp Western sales. Vice Premier Li Peng and others have publicly decried the low utilization rate for imported technology and called for reducing imports while stressing absorption of technology previously imported, making it unlikely that foreign suppliers will be able to sell the same technology to numerous Chinese enterprises. Additional—and ambitious—long-term plans call for using imported technology to improve domestic resources so that China can build the next generation of technology indigenously. While China will continue to import needed advanced equipment and technology, efforts to implement these policies are likely to shrink opportunities for selling some technologies—such as selected telecommunications or microcomputer production technology—to China over the long run.

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